LECTURE 1, Chapter 1: Terminology and Basic Computation

Statistics

The term "statistics" is defined as a set of mathematical methods that allow researchers to summarize, organize, and interpret the data that they have collected from their research studies.

Descriptive and Inferential Statistics

There are two major categories of statistics: descriptive statistics and inferential statistics. Descriptive statistics are methods that can organize, summarize, and simplify data. Descriptive statistics methods include organizing and summarizing data into frequency tables, histograms, or bar graphs, calculating measures of central tendency (mean, median, and mode), and calculating measures of variability (standard deviation).

Descriptive Statistics

Descriptive statistics can "***describe***" the data, but cannot explain ***why*** the data are as they are. For example, if I wanted to know the average GPA for students who are presently taking this class, I could ask each student for his or her GPA. Once I gathered all the GPA data, I could, for example, calculate a descriptive measure called the mean (the arithmetic average). The mean is a descriptive statistical method that allows me to describe the students' GPA data; in other words, one way to summarize or describe the GPA data is to note its mean (the arithmetic average). Further, I could organize and summarize the GPA data by constructing a frequency table or a graph. Again, these **descriptive** methods would organize and simplify the data (make it easy to get an overview of what the data look like), but these methods **cannot** tell me ***why*** the GPA data are what they are. In other words, I cannot know why one student has a higher GPA than another. Descriptive statistics methods do just what their name states: ***describe*** data but cannot ***explain*** data.

Inferential Statistics

On the other hand, **inferential statistics** allows researchers to **explain** the data. Often, inferential statistics are used to analyze data from experiments, which is the research method that allows a researcher to establish a cause and effect relationship between two variables. Inferential statistics allows researchers to study samples and infer their research findings to populations. We will begin inferential statistics later in this course. At this point, you should simply note that there are two major categories in statistics: descriptive and inferential. You should aim to gain a sense of the difference between these major categories as you read Chapter 1.

Population, Sample, Parameter, Statistic, and Sampling Error

The terms **population, sample, parameter, statistic, and sampling error** have specific relationships among them. While reading and studying, you should aim to understand the definition of each of these terms as well as how they are related to each other.

Population

A **population** is the **entire** group that a researcher is interested in studying. For example, a researcher may want to study whether a specific teaching method increases the math ability of five-year-olds. The researcher must select and define the population of interest; for example, does the researcher want to study all five-year-olds in the United States or all five-year-olds in the Northeastern States? The population would be defined by the entire group of five-year-olds that the researcher wants to study. Again, the population is the **entire** group of people, animals, corporations, or any other entire set that the researcher wants to study. However, it is often not possible to study the entire population because populations are usually too large to allow a researcher to measure everyone in it. Therefore, researchers don't often (almost never) study populations. Instead, researchers select a **sample** from the population and study it.

Sample

A **sample** is a group of individuals selected from a population that actually take part in a research study. In other words, the sample is a subset of the population. We will discuss types of sampling later in the course. For now, realize that while researchers want to study and learn about populations, they typically use samples rather than populations in their research studies. Researchers get their samples from the population of interest, study the sample, and infer the results to the population of interest. It is inferential statistics that allows researchers to analyze data from samples and infer the results to the population of interest.

Parameter (μ) and Statistic (M)

Parameter and statistic are terms that differentiate population data from sample data, and each has its own statistical notation. Summarized data from a population are referred to as **parameters** and summarized data from a sample are referred to as a **statistic.** For example, if I wanted to know the mean (average) GPA for everyone taking this course, my population would consists of all students who are taking this course. I could collect and record each student's GPA. If I did that, then I would have a data set that represents a population data set; that is, my data set includes the entire group that I want to study. If I calculated a mean (an average) for the entire set (the population) of the students' GPAs, I would have calculated a parameter. That is, the average (mean) of the GPA data set describes a population, and information that describes a set of data from a population is called a parameter. The mean of the population, an example of a parameter, is statistically represented by "μ".

If it were not possible for me to get a GPA from the entire population of students who are taking this course, I could, instead, select a sample of students from the course. If I did that, then I would compute an average (a mean) for the sample of students' GPAs. The sample mean would be called a **statistic** rather than a parameter because the mean, in this case, describes a sample of data rather than a population of data. The statistical notation for a sample mean is M.

Sampling Error

Because researchers are interested in populations and not samples, but study samples rather than populations, it is important that the samples are representative (look like) the population. Samples, however, will not look exactly like the populations from which they were selected. An example that I often use in the on-campus class is that if you were going to go into the supermarket to get a "sample" of fruit from the "population" of fruit (all the fruit that was available), the sample of fruit would likely be different than the population. For example, if the supermarket has 100 different kinds of fruit and you were going to select a sample of 25 fruits, it would be impossible to have a sample that represents the entire population (that the sample fruits would reflect all the fruits in the population). Some of the population (fruit type) would be in your sample and some would not. The lesson here is that anytime a researcher selects a sample from a population for a research study, he or she should expect some difference between the sample and the population or, stated in statistical language, a difference between the population parameter and the sample statistic. This expected difference is called **sampling error**.

Discrete vs. Continuous Variables (LO 1.2)

Variables can be classified as discrete or continuous

Discrete Variables

Discrete variables are usually noted in statistics texts as variables that consist of indivisible categories. What this means is that some variables cannot be measured in units other than whole numbers, such as the number of children in a classroom, the number of offices in a professional building, the number of errors a rat makes while learning to navigate a maze, the number of multiple choice questions incorrectly answered on an exam, and so on. Stated in a different way, a discrete variable cannot be broken into further categories; for example, one child is just that: one child! You cannot further break down that category of 1 child into a quarter child, a half of a child, etc.

Continues Variables

Continuous variables, on the other hand, can be divided into infinite categories. Common examples of continuous variables are time, height, and weight. These are continuous variables because they can be divided into infinite categories. For example, if you are measuring time, then you can divide an hour into minutes, minutes into seconds, half-seconds, and so on…infinitely. Because students often find discrete vs. continuous variables confusing, perhaps one more example will help.

If you were measuring the number of colds someone gets a year, would colds be a discrete or continuous variable? Think about it for a minute. It would be a discrete measurement (variable) because someone can get 1 cold, 2 colds, 3 colds, 4 colds, and so on. But, they cannot get 1.3 colds. They either get a cold or they do not get a cold. The variable, colds, is an indivisible category. If, however, you were going to measure *how long a cold lasts* (time), then a cold can last 2 days, 2.1 days, 2.2 days, and so on. Therefore, the *time* one has a cold is a continuous variable.

Scales of Measurement

Researchers need to take measurements (make observations and record them) in order to collect data on which they are interested in studying. Measuring their variables of interest requires the researchers to use a set of categories called **scales of measurement**. There are four scales of measurement: nominal, ordinal, interval, and ratio.

Nominal

If a psychologist were hired to measure the types of psychological/psychiatric disorders that patients in a large psychiatric ward were given as a diagnosis, then the measurement scale would be a ***nominal*** one because the categories would be the diagnoses (names). The categories in a nominal scale are often "names." In this example, the scale could have categories such as, depressive disorders, anxiety disorders, and psychotic disorders and each of the patient's diagnosis would be categorized in one of the nominal scale's categories.

Ordinal

An ***ordinal*** scale is like a nominal scale, but the categories can be placed in some **rank** order. For example, students' grades, A, A-, B+, B, B-, C+C, D+, D, F, are on an ordinal scale. That is, the categories are "nominal" (names), but the categories (grades) can be put in an **order** wherein an A represent a higher grade than B. Again, the "name" categories can be ranked. This is what primarily differentiates a nominal from an ordinal scale.

Interval and ratio

Interval and ratio scales are primarily differentiated as a function of whether or not there is a real zero. A real zero means that when a researcher is measuring a variable, it is possible to get a measure of "zero," wherein the zero represents *the absence of that which is being measured*. For example, if you were measuring the number of correct responses on a quiz and your measurement was zero, the zero represents the complete absence of that which you are measuring: correct responses. However, if you were to measure temperature in a room and the temperature was zero, that zero **does not** represent the complete absence of that which you are measuring. The temperature is zero, but that zero does not mean that there is a complete absence of temperature. Therefore, temperature is not measured on a ratio scale; but rather, it is measured on an interval scale. These distinctions are important because the type of scale used determines the appropriate descriptive and inferential statistics than be used to organize, summarize, and interpret the data.

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Statistical Notation and Computation of Sums

The following is statistical notation with which you should become familiar:

μ = the mean of a population

M = the mean of a sample

N = the number of scores in a population

n = the number of scores in a sample

$\sum$ = summation sign (to sum)

X = raw score

$\sum X$ = sum the scores

$(\sum X)^2$ = sum the scores and then square the sum

$\sum X^2$ = square each score and then add up the squared scores.

Let us take a look at a set of scores from a population:

X
3
4
1
5

You must be able to calculate the following terms from the data set above: N, $\sum X$, $(\sum X)^2$, $\sum X^2$

What is N for the above set of data?
N is the number of scores in a data set; therefore, N= 4 because there are four X's (raw scores in the data set)

What is $\sum X$?
$\sum X$ means to sum the scores; therefore 3+4+1+5 = 13 $\sum X = 13$

What is $(\sum X)^2$?
$(\sum X)^2$ requires you to sum the scores first and then square the sum; therefore, first you add up the scores = 13 and then square the 13 so that $(EX)^2 = (13)^2 = 169$

What is $\sum X^2$?

$\sum X^2$ requires that you square each score first and then add the squares; therefore you have to take the original scores 3, 4,1, and 5 and square each one first: $3^2 = 9$, $4^2 = 16$, $1^2 = 1$, and $5^2 = 25$. Then you sum the squares 9+ 16+ 1+ 25 = 51 so that $\sum X^2 = 51$